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Patent, Trademark and
Copyright Matters

July 2, 1999

2030 Main Street, Suite 1050
Irvine, California 92614
Telephone: (949) 476-0600
Facsimile: (949) 476-0606
morlandf@earthlink.net

BOX PATENT APPLICATION
Commissioner of Patents and Trademarks
United States Patent and Trademark Office
Washington, D.C. 20231

Sir:

Transmitted herewith for filing in the United States Patent and Trademark Office is the patent application of:

Inventor (s): Kenneth Alan Pieroni and Jim Eli Saffie
Docket No.: CHMP-102
For: **SMOKE AND CLEAN AIR GENERATING MACHINE FOR DETECTING
THE PRESENCE AND LOCATION OF LEAKS IN A FLUID SYSTEM**
Dated: Herewith

The application consists of twenty-five (25) pages, four (4) sheets of drawings; a Declaration and Power of Attorney, a Declaration Claiming Small Entity Status (2), and a check in payment of the filing fee. The filing fee has been calculated as follows:

Basic Fee:		\$380.00
Total Claims:	18 - 20 x \$ 9 =	.00
Independent Claims:	3 - 3 x \$ 39 =	.00
Multiple Dependent Claims	0 x \$130 =	<u>.00</u>
Total		\$380.00

Should any additional fee be required or should any excess fee be paid, please charge or credit such amounts to Account No. 08-1310.

Respectfully submitted,

Morland C. Fischer
Morland C. Fischer

MCF/cdo

Enclosure

Docket No. CHMP-102

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant (s): Kenneth Alan Pieroni and Jim Eli Saffie

Serial No.: Unknown

Filed: On even date herewith

Title: **SMOKE AND CLEAN AIR GENERATING MACHINE FOR
DETECTING THE PRESENCE AND LOCATION OF LEAKS IN A
FLUID SYSTEM**

DECLARATION CLAIMING SMALL ENTITY

As an assignee or licensee in and to the above-identified invention and application, I hereby declare that I qualify under 37 CFR 1.9(c) and (d) for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States code, to the Patent and Trademark Office with regard to the invention set forth in the application identified above.

I have not assigned, granted, conveyed or licensed, and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

I acknowledge my duty to file, in this application or in any patent issuing thereon, notification of any change resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the issue fee or any maintenance fee due after the date on which the status as a small entity is no longer appropriate.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Name of Assignee:

Champion Engineering, LLC
2444 Fender Avenue, #C
Fullerton, California 92831

By:


Kenneth Alan Pieroni - President

6-21-99
Dated

PATENT

Attorney Docket No.: CHMP-102

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant (s): Kenneth Alan Pieroni and Jim Eli Saffie
Serial No.: Unknown
Filed: Herewith
Title: **SMOKE AND CLEAN AIR GENERATING MACHINE FOR
DETECTING THE PRESENCE AND LOCATION OF LEAKS IN A
FLUID SYSTEM**

DECLARATION CLAIMING SMALL ENTITY STATUS

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9 (c) for purposes of paying reduced fees under Section 41 (a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention set forth in the application identified above.

I have not assigned, granted, conveyed or licensed, and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9 (c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9 (d) or a nonprofit organization under 37 CFR 1.9 (e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed, or am under an obligation under contract or law to assign, grant, convey, or license, any rights in the invention are identified as follows:

- > Champion Engineering, LLC
2444 Fender Avenue, #C
Fullerton, California 92831

I acknowledge my duty to file, in this application or in any patent issuing thereon, notification of any change resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the issue fee or any maintenance fee due after the date on which the status as a small entity is no longer appropriate.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Full Name of First or Sole Inventor: Kenneth Alan Pieroni

KA Pieroni 6-21-99
Signature of First or Sole Inventor Date

Full Name of First or Sole Inventor: Jim Eli Saffie

Jim Saffie 6/21/99
Signature of First or Sole Inventor Date

**SMOKE AND CLEAN AIR GENERATING MACHINE FOR
DETECTING THE PRESENCE AND LOCATION OF
LEAKS IN A FLUID SYSTEM**

BACKGROUND OF THE INVENTION

1. **Field of the invention.**

This invention relates to a compact, easy to use and portable smoke and clean air generating machine that enables the presence and location of leaks in a fluid system (e.g. the evaporative or brake system of a motor vehicle) to be accurately and visually detected depending upon the rate of air flow through the fluid system under test and whether smoke escapes from the system.

2. **Background art.**

Our Patent Application No. 09/020,841 filed February 9, 1998 and entitled SMOKE PRODUCING APPARATUS FOR DETECTING LEAKS IN A FLUID SYSTEM discloses an efficient, portable apparatus for generating smoke in order to locate leaks in a fluid (e.g. air, oil, fuel, exhaust, etc.) system. A supply of oil within a sealed chamber is vaporized, and the resulting smoke is delivered to the system under test. By visually inspecting the system for smoke escaping therefrom, the precise location of a leak in the system can be accurately detected.

With the growing emphasis being placed on reducing the volume of emissions leaking into the atmosphere, it has become increasingly important to be able to monitor

and test the integrity of a fuel vapor recovery or evaporative system in today's motor vehicles. By way of example, to test for leaks, the evaporative system of a motor vehicle is typically pressurized for a predetermined time. If the pressure holds throughout the time interval, then the integrity of the system is presumed to be intact.

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The problem is that this conventional method of testing for leaks in the vapor recovery system of a motor vehicle does not take into account the volume of fuel stored in the gas tank. That is to say, the smaller the volume of fuel stored in the gas tank, the greater will be the empty space within the tank lying above the fuel supply. Such empty space acts an air and pressure accumulator. More particularly, for a vehicle with less fuel and a larger air space in its tank, it will take a longer time to detect a leak. Therefore, the test operator can receive a false indication as to the integrity of the evaporative system, because of the increased time that is required for this system having an air accumulator to be fully pressurized. Consequently, an evaporative system which shows that it is holding pressure over time may actually have a leak and be in need of repair to avoid emissions to the atmosphere.

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Accordingly, it is desirable to be able to overcome the aforementioned problems associated with the conventional method of testing for leaks in a fluid system so that the existence and location of a leak may be accurately verified and detected. To this end, it would also be desirable to achieve this goal by using the efficient smoke generating apparatus that is described in our above-entitled patent application.

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SUMMARY OF THE INVENTION

Briefly, and in general terms, a smoke and clean air generating machine is disclosed that is adapted to produce either a supply of clean air or a supply of smoke to a fluid system (e.g. the evaporative or brake system of a motor vehicle) to be tested for leaks. An air compressor provides a supply of air under pressure. The air compressor is connected to supply air to a smoke generating apparatus or to a flow meter by means of a two-way bleed off selector valve. More particularly, with the selector valve rotated to a clean air position, the air compressor will communicate with the flow meter which measures the rate of air being delivered to the system under test. With the selector valve rotated to a smoke position, the air compressor will be connected to the smoke generating apparatus so that a supply of oil in a sealed chamber can be blown towards and vaporized by a heating grid and the resulting smoke delivered to the system under test. However, when the selector valve passes through a center position between its smoke position and clean air position, any pressure that has been developed in the air line between the air compressor and the smoke generating apparatus will be exhausted (i.e. bled off) to the atmosphere so as to automatically de-energize the heating grid of the smoke generating apparatus and thereby insure that the heating grid will cool and no additional smoke will be generated.

In operation, the selector valve is first rotated to its clean air position, whereby a supply of clean (i.e. non-smoky) air is delivered from the air compressor to the system under test via the flow meter. An air accumulator having an integral check valve to relieve excess pressure is located between the selector valve and the flow meter to

smooth any pulsations in the flow of air to the meter. The existence of a leak having sufficient size to require repair is indicated in the event that the flow meter reads a rate of air flow from the air compressor to the system under test which is greater than a predetermined flow rate that is characteristic of a leak free system. Should a leak be indicated, the selector valve is then rotated to its smoke position, whereby a supply of air is delivered from the air compressor to the smoke generating apparatus. The smoke generating apparatus generates a supply of smoke via a smoke outlet line thereof to the fluid system under test. By visually inspecting the system under test for any escaping smoke, the precise location of a leak can be determined. Coupled to the smoke outlet line of the smoke generating apparatus is a pressure discharge accumulator having an integral check valve that is adapted to open to relieve excess pressure. In the event of a pressure build-up in the smoke outlet line (such as when the system to be tested is partially or completely restricted), the smoke is diverted to the check valve. As the exiting smoke begins to cool and condense, droplets of oil will be collected within the pressure discharge accumulator. The excess pressure within the smoke outlet line will then be dissipated to the atmosphere through a small orifice in the accumulator.

As an alternate embodiment of the present invention, the air compressor to deliver clean air to the flow meter and the smoke generating apparatus can be replaced by a pressure and flow regulated source of non-flammable nitrogen gas. In this case, a mixture of nitrogen (rather than air) and smoke will travel through the smoke outlet line to be delivered to the system under test so that a relatively safe, non-explosive

environment can be established, particularly in situations characterized by high temperatures.

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BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a schematic of the smoke and clean air generating machine which forms the present invention for verifying the presence and detecting the location of leaks in a fluid system under test;

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FIG. 2 shows a 2-way selector valve from the smoke and clean air generating machine of FIG. 1 rotated to a clean air position for connecting an air compressor to the fluid system under test by way of a flow meter;

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FIG. 3 illustrates the selector valve of FIG. 2 rotated to a smoke position to connect the air compressor to a smoke generating apparatus; and

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FIG. 4 shows the selector valve rotated to a center position between the clean air and smoke positions of FIGs. 2 and 3 for discharging pressure through the selector valve to control the operation of the smoke generating apparatus.

DETAILED DESCRIPTION

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Referring to the drawings, there is shown in FIG. 1 a smoke and clean air generating machine having an outer casing (designated by phantom lines) 50 within which is housed a smoke generating apparatus 1 that is adapted to generate a supply of

smoke to a smoke outlet line 2 and a smoke supply line 4 so that a fluid system (not shown) can be visually inspected for leaks. The smoke generating apparatus 1 has been described in detail in our earlier Patent Application Serial No. 09/020,841 filed February 9, 1998, the teachings of which are incorporated herein by reference. Therefore, a full
5 description of the smoke generating apparatus 1 will not be provided.

Briefly, however, the smoke generating apparatus 1 includes a sealed chamber 6 which contains a non-toxic oil supply 8. An air inlet tube 10 projects upwardly from the bottom of chamber 6 and extends above the oil supply 8. Inlet tube 10 communicates
10 with an external air compressor 25 through a wall of chamber 6. An inlet orifice 12 is formed in the air inlet tube 10 so as to lie within the oil supply 8 immediately above the bottom of chamber 6. A resistor heating grid (e.g. coil) 14 extends laterally across the sealed chamber 6 and is electrically connected to a 12 volt battery 16 by means of an electric pressure switch 36. A fluid baffle 18 having a smoke outlet orifice 20 formed
15 therein extends laterally across the sealed chamber 6 above the heating grid 14. The aforementioned smoke outlet line 2 communicates with the outlet orifice 20 through the top wall of the sealed chamber 6.

In operation, when the pressure switch 36 is closed, the battery 16 supplies
20 current to heat the heating grid 14, and the air compressor 25 delivers air into the sealed chamber 6 via air inlet tube 10 at approximately 14 liters/minute to cause some of the oil supply 8 within the chamber to be drawn, by means of suction through inlet orifice 12 and into the air inlet tube 10. A mixture of air and oil is then blown upwardly and

outwardly from the air inlet tube 10 towards and into contact with the heating grid 18, whereby the oil is instantaneously vaporized into smoke. The rising smoke travels through the outlet orifice 20 in fluid baffle 18 for receipt by the smoke outlet line 2. Accordingly, the smoke in outlet line 2 is carried by way of the smoke supply line 4 to
5 the fluid system to be tested so that the integrity of the system may be visually inspected for leaks depending upon the absence or presence of smoke escaping therefrom.

In accordance with the present improvement, a two-way never closing bleed-off selector valve 30 is provided to control the flow of air from the compressor 25 to either
10 the smoke generating apparatus 1, when it is desirable to generate smoke to be delivered to the system to be tested for leaks, or to a flow meter 32, when it is desirable to supply clean (i.e. non-smoky) air to the system to be tested. The selector valve 30 is rotated to a clean air position to connect the air compressor 25 to the flow meter 32, whereby clean
15 air will by-pass the smoke generating apparatus 1 for receipt by the system to be tested via the smoke supply line 4 when it is desirable to verify the existence and size of a potential leak in the system. Since smoke carries oil and particulate matter, it is not desirable for smoke to pass through the flow meter 32. Such smoke can cause the flow meter 32 to malfunction and eventually fail.

20 The selector valve 30 is rotated to a smoke position to cause the air compressor 25 to communicate directly with the smoke generating apparatus 1, whereby smoke can be generated to identify the specific location of a leak in the system to be tested. As will be described in greater detail hereinafter when referring to FIG. 2-4, the selector valve 30 is

also rotated to a center position (i.e. during the transition between the smoke and clean air positions) when it is desirable to bleed-off pressure that has been developed in the smoke outlet line 2 by the air compressor 25.

5 With the selector valve 30 rotated to the smoke position to connect the air compressor 25 to the smoke generating apparatus 1, air, under pressure, will be supplied to the air inlet tube 10 inside the sealed chamber 6 by way of a seven pound cracking pressure check valve 34. Pressure check valve 34 performs two different functions. In one case, the pressure check valve 34 functions as a conventional one-way check valve to
10 block the reverse flow of oil from the smoke generating apparatus 1 to the selector valve 30. In addition, check valve 34 also prevents the backflow of oil from chamber 6 should the casing 50 be accidentally tipped. In a second case, the pressure check valve 34 establishes a back pressure in the air supply line between check valve 34 and air compressor 25. Such back pressure is required to activate the aforementioned electric
15 pressure switch 36 which is connected to the battery 16 and which must be closed before current will be supplied from battery 16 to the heating grid 14 within the chamber 6 of smoke generating apparatus 1.

 The electric pressure switch 36 is a conventional, normally open pressure
20 activated contact switch. When the selector valve 30 is rotated to its smoke position, the normally open electric pressure switch 36 will be closed in response to the pressure that is established in the line between check valve 34 and air compressor 25. Once switch 36 is closed, a current path will be created between the battery 16 and the heating grid 14 of

smoke generating apparatus 1 so that the droplets of oil that are blown towards heating grid 14 from oil supply 8 will be vaporized into smoke within chamber 6. However, as an important feature of this invention, when the selector valve 30 is rotated from its smoke position so as to move through the center position thereof (best described when referring to FIG. 4), an air path will be created through selector valve 30 by which to relieve the back pressure that was previously established behind check valve 34. In particular, such back pressure will be discharged through selector valve 30 to the air compressor 25 or to a soon to be described air accumulator 42. Hence, the electric pressure switch 36 will be responsive to such pressure loss, whereby to automatically return to its normally open switch condition and thereby break the current path between the battery 16 and the heating grid 14 of smoke generating apparatus 1. Accordingly, the heating grid 14 will cool and the generation of smoke will cease.

As another important feature of this invention, the smoke outlet line 2 from the sealed chamber 6 of smoke generating apparatus 1 is coupled to a pressure discharge accumulator 38 through a one pound cracking pressure check valve 40. As shown, the pressure check valve 40 is positioned upstream and between the smoke generating apparatus 1 and the system to be tested so as to be responsive to the output pressure of the smoke that is carried by the smoke outlet line 2 after selector valve 30 has been rotated to its smoke position. By virtue of the foregoing, when the smoke supply line 4 or the fluid system to be tested is partially or fully restricted, the pressure check valve 40 will open, whereby smoke and/or pressure that builds up within the smoke supply line 4 will be able to escape to the atmosphere through an orifice in the pressure discharge accumulator 38.

At the same time, the open pressure check valve 40 will allow air (including any oil products that are carried therein) to continue to circulate through the chamber 6 of smoke generating apparatus 1 in order to produce smoke therewithin. Such continued circulation will advantageously prevent the heating grid 14 of smoke generating apparatus 1 from overheating at times when the system to be tested is blocked and smoke within the outlet line 2 would otherwise be trapped.

Locating the pressure check valve 40 after the smoke producing apparatus 1, rather than prior to the air inlet tube 10 of chamber 6 (e.g. between inlet tube 10 and pressure check valve 34), avoids an early release of some or all of the pressure which would reduce or eliminate the air and oil circulation process that is otherwise achieved in the manner described above by coupling the smoke outlet line from chamber 6 to the pressure check valve 40. Thus, with the present improvement, it will still be possible to generate smoke so as to locate any leaks in the fluid system to be tested even during situations where the fluid system and/or the smoke supply line 4 is partially or completely restricted.

Locating the combination of pressure discharge accumulator 38 and pressure check valve 40 upstream from the smoke generating apparatus 1 will permit any oil products that have been vaporized by the heating grid 14 and carried through an open check valve 40 to condense and collect within the accumulator 38 during less than full flow conditions in the smoke outlet line 2. Such condensation reduces the amount of unwanted oil that would otherwise be released into the environment from the pressure

discharge accumulator 38 under abnormally high pressure conditions within the smoke outlet line 2 when the pressure check valve 40 is open. In other words, accumulator 38 collects the residue after the oil supply 8 from sealed container 6 is first vaporized by heating grid 14 into smoke and then condensed back into oil following contact with check valve 40. Without accumulator 38 to collect the oil residue, the oil carried by the smoke could build up on the outlet side of the pressure check valve 40 and eventually spill out each time that the check valve 40 would open to release pressure. Such oil spillage could be undesirably encountered at the exterior of the casing 50 in which the smoke generating apparatus 1, selector valve 30 and pressure check valve 40 are all housed and transported from place to place.

At such time when the selector valve 30 is rotated to its clean air position (when no smoke is being generated by apparatus 1), an air path is established between compressor 25 and a pre-meter air accumulator 42. Air accumulator 42 is preferably a hollow chamber or air damper that functions to reduce or dampen the fluctuation to which flow meter 32 would be subjected that might alter the reading of flow meter 32 as a consequence of the pulsations that are common to a piston-type air compressor, such as that which has been shown and described herein, and the opening and closing of a soon to be described check valve 44. In this same regard, it would be possible to eliminate the air accumulator 42 altogether if the air compressor 25 were replaced by a non-pulsating air pump. However, a pulsating piston-type air compressor 25 is preferable because it is known to be reliable and readily available for use in the present invention.

A one-half pound check valve 44 is coupled to the air accumulator 42. Check valve 44 functions to relieve excess pressure within the clean air supply line 46 when clean air is supplied via flow meter 32 and the system to be tested or the smoke supply line 4 is partially or fully restricted. It is important that the check valve 44 be positioned behind (i.e. downstream from) the flow meter 32. During clean air operation, with selector valve 30 rotated to its clean air position, if check valve 44 were located ahead of (i.e. upstream from) flow meter 32, then the flow meter 32 would continue to meter clean air passing therethrough even if the system to be tested or the smoke supply line 4 were blocked.

Connected in the clean air supply line 46 which runs from flow meter 32 to smoke supply line 4 is a directional check valve 48. Check valve 48 limits the flow of clean air from air compressor 25 to a single direction away from flow meter 32 so that smoke produced by smoke generating apparatus 1 will be unable to pass through the clean air supply line 46 to contaminate the flow meter 32 and loose pressure through check valve 44 which would undesirably reduce the efficiency of operation.

On the other hand, to maximize the efficiency of the smoke and clean air generating machine of this invention, it is important that the check valve 44 on the clean air side have a lower cracking or threshold pressure (e.g. one-half pound) than the cracking pressure (e.g. one pound) of the check valve 40 on the smoke side. As previously described, if the system to be tested or the smoke supply line 4 were partially or completely restricted after selector valve 30 is rotated to its clean air position, any

excess pressure that is built up in the clean air supply line 46 would escape through check valve 44 of air accumulator 42. However, if the cracking pressure of check valve 40 were less than the cracking pressure of check valve 44, then flow meter 32 will continue to meter air flow therethrough even during such high pressure conditions. By virtue of the present improvement, if the system to be tested or the smoke supply line 4 were blocked when the selector valve 30 is rotated to its smoke position, then the smoke generated by apparatus 1 will escape through check valve 40, since the directional check valve 48 will not allow the back flow of smoke through the clean air supply line 46 and towards flow meter 32.

Although the smoke generating apparatus 1 has been described above as receiving air under pressure from an air compressor 25, it is to be understood that gases other than air may be supplied to the air inlet tube 10 of apparatus 1 to cause a mixture of such gas and oil to be blown towards the heating grid 14. More particularly, testing the integrity of the evaporative system in a motor vehicle is now required by the Environmental Protection Agency in many states. It has become essential to be able to verify if the evaporative system has a leak and then identify the location of the leak. As an alternative to pressurized air, carbon dioxide or nitrogen gas from a pressure and flow regulated tank or bottle 60 can be used because of their non-flammable and inert characteristics. That is to say, smoke carried by nitrogen gas would be relatively safe for testing the evaporative system of a motor vehicle which lies in a generally volatile environment of potentially explosive hydrocarbon vapors. Accordingly, the ability to produce smoke with nitrogen gas would provide a safe and efficient means for locating a leak in the evaporative system

of a motor vehicle. Moreover, producing smoke with nitrogen gas rather than air would enable a variety of high pressure systems (e.g. an air brake system) to be tested at high operating temperatures but without the inherent risks of an explosion.

5 What is even more, other sources of air under pressure, other than air compressor 25, may be employed to blow the oil towards the heating grid 14. For example, conventional shop air such as that used by an automotive repair facility may be substituted for compressor 25.

10 The advantage provided by the smoke and clean air generating machine of this invention is not only the ability to indicate the precise location of a leak (when selector switch 30 is rotated to the smoke position), but also to first verify whether the system to be tested has a leak in need of repair (when selector switch 30 is rotated to the clean air position). More particularly, the flow meter 32 that is connected in the clean air supply
15 line 46 is a non-regulating flow meter that has a ball indicator to provide a visual reading when the system to be tested has a leak that is of sufficient size to warrant repair. Flow meter 32 is first initialized to a flow rate setting that corresponds to a leak size in the fluid system of 1 millimeter in diameter, a size which is generally considered in the industry to represent the standard tolerance level of a fluid system before the repair of a leak is
20 required. Of course, the initial setting of flow meter 32 could change in the event that the tolerance standards of fluid systems subjected to leaks also change.

Once the selector valve 30 is rotated to its clean air position to connect air compressor 25 to flow meter 32, should the fluid system have a leak size which is in tolerance (i.e. less than 1 millimeter) then the reading of flow meter 32 will be at or below the initialized flow rate, and no repair will be necessary. However, should the fluid system have a leak, the size of which is larger than 1 millimeter, then the reading of flow meter 32 will be above the initialized flow rate, such that the leak must be located and repaired. At this point, the selector valve 30 is rotated from its clean air position to its smoke position, whereby a supply of smoke is delivered from the sealed chamber 6 of smoke generating apparatus 1 to the system to be tested in the manner described above.

Turning now to FIGs. 2-4 of the drawings, details of the 2-way bleed-off selector valve 30 are now provided. FIG. 2 shows the selector valve 30 having a manually controlled knob 50 rotated to the clean air position in order to connect the air compressor 25 to the clean air side of the smoke and clean air generating machine of this invention so that a supply of clean air will be delivered to the system under test via the flow meter 32 in order to verify the presence of a leak having sufficient size to warrant repair. In this same regard, the air compressor 25 is disconnected from the smoke generating apparatus 1.

FIG. 3 shows the knob 52 of selector valve 30 rotated 180 degrees from the clean air position of FIG. 2 to the smoke position to connect the air compressor 25 to the smoke side of the smoke and clean air generating machine so that a supply of air will be delivered to the smoke generating apparatus 1. Smoke generated from the sealed

chamber 6 of apparatus 1 is supplied to the system under test via smoke outlet line 2 in order to detect the precise location of the leak in need of repair depending upon a visual observation of smoke escaping through the leak. In this same regard, the air compressor 25 is disconnected from the flow meter 32.

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FIG. 4 shows the knob 52 of selector valve 30 momentarily rotated through a center or neutral position during the transition of knob 52 from the smoke position of FIG. 3 to the clean air position of FIG. 2. In this case, an air path is established through selector valve 30 from the check valve 34 to the air compressor 25 and/or the air accumulator 42 in order to bleed off air pressure from pressure switch 36. As previously described, pressure switch 36 is responsive to such pressure loss and will return to its normally closed condition, whereby to disconnect the battery 16 from the heating grid 14 of smoke generating apparatus 1 so as to allow the heating grid to safely cool and thereby terminate the generation of smoke.

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It may be appreciated that in a conventional selector valve, the center position thereof would typically allow no air to flow in either direction through the valve. However, selector valve 30 of the present invention is a never closing valve such that in its center position, the smoke side of the smoke and clean air generating machine is momentarily placed into communication with the clean air side whereby air pressure will be bled from the smoke side to cause a drop in pressure so that heating grid 14 will cool and no smoke will be generated. As described above, such bleeding off of the air pressure from the smoke side occurs only when selector valve 30 is moved through its

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center or neutral position and, unlike conventional valves, permits the aforementioned communication between the smoke and clean air sides to disconnect heating grid 14 from battery 16.

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CLAIMS

1. Apparatus for generating smoke, comprising:

a smoke producing chamber;

a supply of fluid located within said smoke producing chamber to be vaporized when heated;

5 a heating element located within said smoke producing chamber above said supply of fluid;

a gas inlet communicating with said smoke producing chamber to receive gas under pressure, said gas inlet having an inlet orifice in fluid communication with said supply of fluid so that when gas under pressure is delivered through said gas inlet, some
10 of said supply of fluid is drawn into said gas inlet via said inlet orifice, whereby a mixture of gas and fluid is blown through said gas inlet and against said heating element to be vaporized into smoke when said heating element is heated;

a smoke outlet communicating with said smoke producing chamber to permit said smoke to exit said smoke producing chamber; and

15 a source of non-flammable gas connected to said gas inlet to supply gas under pressure thereto.

2. The apparatus recited in claim 1, wherein said source of non-flammable gas is a supply of nitrogen gas.

3. The apparatus recited in claim 2, wherein said gas inlet is a tube located within said smoke producing chamber, said gas inlet tube running through and extending above

said supply of fluid to blow a mixture of nitrogen gas and fluid against said heating element.

4. Apparatus to test for leaks in a fluid system, said apparatus comprising:

a smoke producing chamber to generate smoke;

a supply of fluid located within said smoke producing chamber to be vaporized when heated;

5 a heating element located within said smoke producing chamber above said supply of fluid;

an air inlet line communicating with said smoke producing chamber to receive air from a source thereof, said air inlet line lying in communication with said supply of fluid so that when air from the source thereof is delivered through said air inlet line, a mixture of air and fluid is blown against said heating element to be vaporized into smoke when said heating element is heated;

a smoke outlet line extending from said smoke producing chamber to carry the smoke generated by said smoke producing chamber to the fluid system under test; and

means responsive to the pressure in said smoke outlet line to cause said pressure in said smoke outlet line to be discharged to the atmosphere when said pressure exceeds a predetermined pressure level.

5. The apparatus recited in claim 4, wherein said pressure responsive means includes a smoke outlet check valve connected between said smoke outline line and the atmosphere, said smoke outlet check valve adapted to receive therethrough the smoke

generated by said smoke producing chamber to discharge the pressure in said smoke
5 outlet line to the atmosphere when the pressure in said smoke outlet line exceeds said
predetermined level.

6. The apparatus recited in claim 5, wherein said pressure responsive means also
includes a pressure discharge accumulator coupled to said smoke outlet check valve and
communicating with the atmosphere such that the pressure in said smoke outlet line is
discharged to the atmosphere from said pressure discharge accumulator via said smoke
5 outlet check valve, said smoke outlet check valve also adapted to condense the smoke
received therethrough into droplets of said fluid, and said pressure discharge accumulator
collecting the droplets of said fluid that have been condensed by said smoke outlet check
valve.

7. The apparatus recited in claim 4, further comprising:

a source of electrical current to be connected to said heating element within said
smoke producing chamber to supply current to said heating element to cause said heating
element to heat; and

5 a pressure responsive switch connected between said source of electrical current
and said heating element and response to the pressure within said air inlet line,

said pressure response switch adapted to connect said source of electrical current
to said heating element when air is received through said air inlet line and delivered to
said smoke producing chamber, and said pressure responsive switch also adapted to

10 disconnect said source of electrical current from said heating element when no air is received through said air inlet line.

8. The apparatus recited in claim 7, further comprising an air compressor to be connected to said air inlet line to supply air to said smoke producing chamber, and an air inlet check valve connected in said air inlet line between said smoke producing chamber and said air compressor to block the flow of the smoke and fluid from said smoke
5 producing chamber to said air compressor.

9. The apparatus recited in claim 8, further comprising an air flow meter communicating with the fluid system under test and a selector valve connected to said air compressor and having a plurality of valve positions,

said sector valve being placed in a first of said plurality of valve positions to
5 connect said air compressor to said flow meter so that air is delivered from said air compressor to the system under test via said flow meter, and

said selector valve being placed in a second of said plurality of valve positions to connect said air compressor to said air inlet line so that air is delivered from said air compressor to said smoke producing chamber via said air inlet line and said air inlet
10 check valve connected therein.

10. The apparatus recited in claim 9, further comprising an air accumulator having an air pressure relief check valve coupled thereto, said air accumulator connected between said selector valve and said air flow meter to reduce fluctuations in the air delivered to

said flow meter from said air compressor, said selector valve being placed in a third of
5 said plurality of valve positions so that said air inlet line between said air inlet check
valve and said selector valve is simultaneously connected to said air compressor and to
the pressure relief check valve of said air accumulator.

11. Apparatus to test for leaks in a fluid system, said apparatus comprising:

a multi-position selector valve;

a source of gas under pressure connected to said multi-position selector valve;

a gas flow meter communicating with the fluid system under test;

5 means for generating smoke to produce smoke to be delivered to the fluid system
under test;

a first gas inlet line connected between said multi-position selector valve and said
means for generating smoke;

a smoke outlet line connected to said means for generating smoke to deliver the
10 smoke produced by said smoke generating means to the fluid system under test; and

a second gas inlet line connected between said multi-position selector valve and
said gas flow meter,

said multi-position selector valve being placed in a first position to connect said
source of gas under pressure to said second gas inlet line so that gas under pressure is
15 delivered to the fluid system under test via said gas flow meter, and said multi-position
selector valve being placed in a second position to connect said source of gas under
pressure to said first gas inlet line so that gas under pressure is delivered to said smoke
generating means.

12. The apparatus recited in claim 11, wherein said source of gas under pressure is a supply of nitrogen gas.

13. The apparatus recited in claim 11, wherein said source of gas under pressure is a supply of air.

14. The apparatus recited in claim 11, further comprising means responsive to the pressure in said smoke outlet line to cause said pressure to be discharged to the atmosphere when said pressure exceeds a predetermined pressure level.

15. The apparatus recited in claim 14, wherein said pressure responsive means includes a pressure discharge accumulator communicating with the atmosphere and a smoke outlet check valve connected between said smoke outlet line and said pressure discharge accumulator, said smoke outlet check valve adapted to discharge the pressure in said smoke output line to the atmosphere via said pressure discharge accumulator when the pressure exceeds said predetermined pressure level.

16. The apparatus recited in claim 11, further comprising a source of electrical current to be connected to said smoke generating means to supply current to said smoke generating means in order to produce smoke and a pressure responsive switch connected between said source of electrical current and said smoke generating means and responsive to the pressure within said first gas inlet line, said pressure responsive switch

adapted to connect and disconnect said source of electrical current to said smoke generating means depending upon the pressure within said first gas inlet line.

17. The apparatus recited in claim 11, further comprising a gas pressure relief check valve connected between said second gas inlet line and the atmosphere and responsive to the pressure within said second gas inlet line to cause said pressure within said second gas inlet line to be discharged to the atmosphere when said pressure exceeds a
5 predetermined pressure level.

18. The apparatus recited in claim 11, wherein said multi-position selector valve is placed in a third position to simultaneously connect said first gas inlet line to said second gas inlet line and to said source of gas under pressure.

ABSTRACT

A smoke and clean air generating machine for detecting the presence and location of leaks in a fluid system (e.g. the evaporative or brake system of a motor vehicle). A source of gas (e.g. air or nitrogen) under pressure is delivered to a smoke generating apparatus or to a flow meter by way of a multi-position selector valve. With the selector valve in a first position, gas is delivered to the system under test via the flowmeter to detect the presence of a leak in need of repair depending upon the reading of the flow meter. With the selector valve in a second position, gas is delivered to the smoke generating apparatus so that smoke can be supplied to the system under test to locate the leak. With the selector valve in a third position between the first and second positions, pressure is bled from the machine to disable the smoke generating apparatus and thereby terminate the production of smoke.

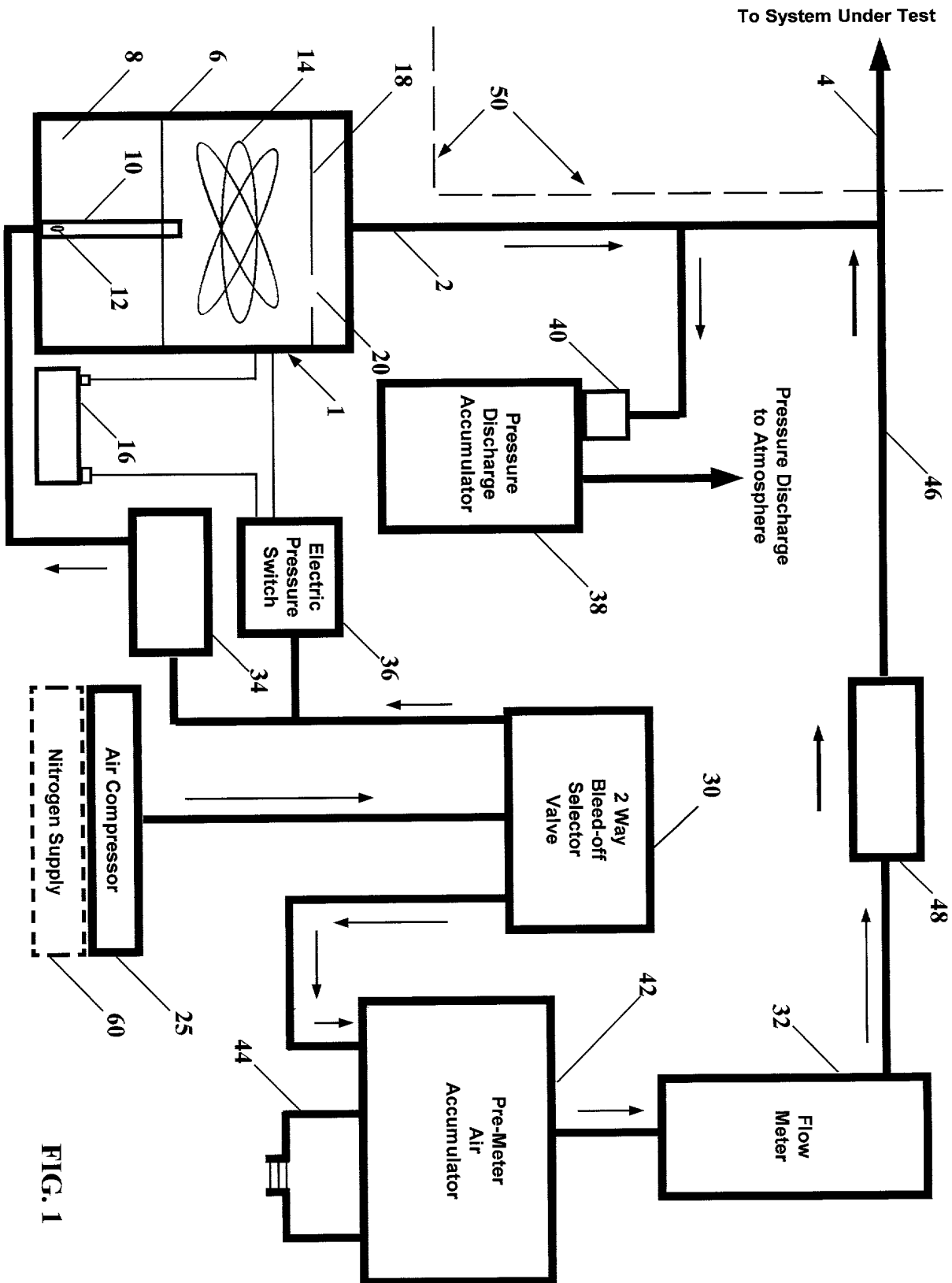


FIG. 1

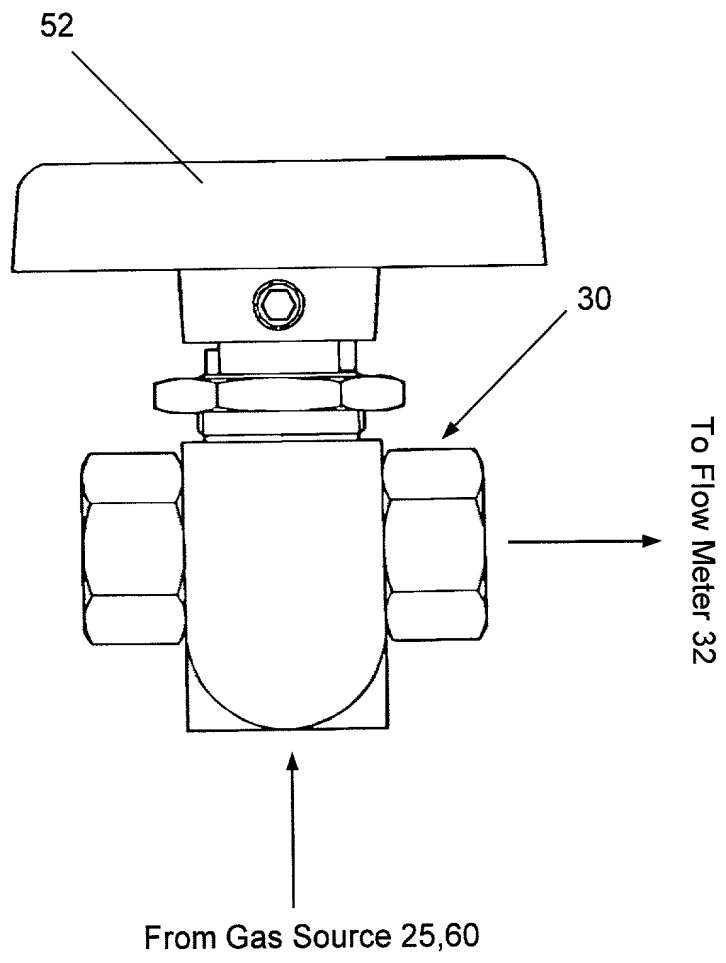


Fig. 2

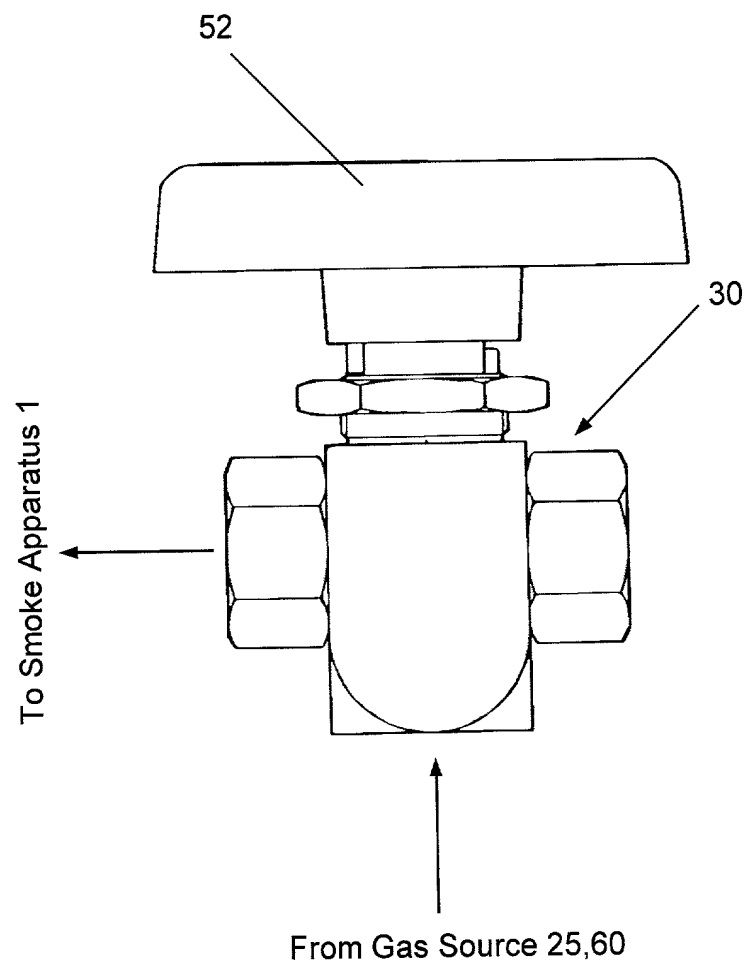


Fig. 3

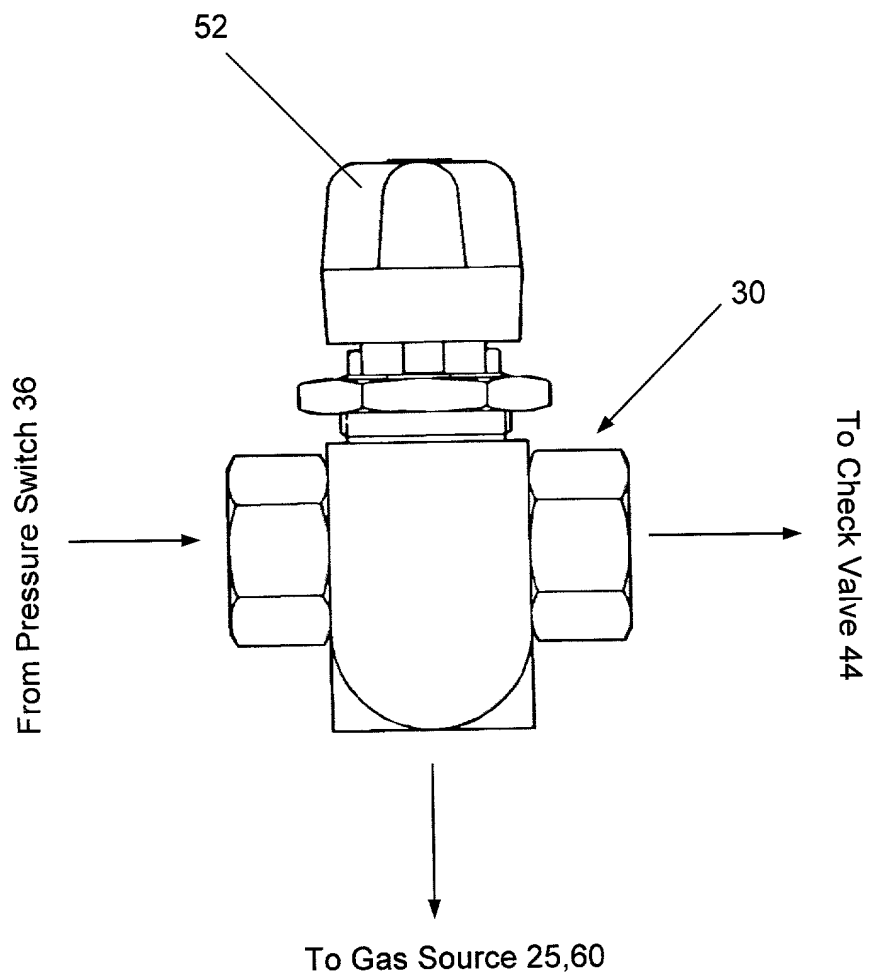


Fig. 4

PATENT

Attorney Docket No.: CHMP-102

DECLARATION AND POWER OF ATTORNEY

As a below named inventor of the invention claimed in the attached application for United States Letters Patent, I hereby declare that:

INVENTORSHIP IDENTIFICATION

My residence, post office address and citizenship are as stated at the end of this declaration next to my name; I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the invention which is claimed in the attached application entitled:

**SMOKE AND CLEAN AIR GENERATING MACHINE FOR
DETECTING THE PRESENCE AND LOCATION OF
LEAKS IN A FLUID SYSTEM**

INVENTORSHIP CLAIM

I do not know and do not believe that this invention was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that this invention was not in public use or on sale in the United States of America more than one year prior to this application, that this invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows:

> NONE

ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I have reviewed and understand the contents of the attached application, including the specification and claims thereof, and acknowledge my duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56 (a).

PRIORITY CLAIM

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119 of any foreign application (s) for patent or inventor's certificate, or of any PCT international application (s) designating at least one country other than the United States of America, filed by me on the same subject matter as set forth in the attached application, namely:

> NONE

I hereby claim the benefits under Title 35, United States Code, section 120 of any United States application (s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, section 1.56 (a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

> NONE

POWER OF ATTORNEY

As a named inventor, I hereby appoint the following attorney to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith:

Morland C. Fischer

Registration No. 26,881

with offices located at 2030 Main Street, Suite 1050, Irvine, California 92614 (tel. 949-476-0600).

Please direct all correspondence and telephone calls to **Morland C. Fischer** at the above-noted address and telephone number.

DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or patent issuing thereon.

SIGNATURES

Full name of first or sole inventor: Kenneth Alan Pieroni

Inventor's signature: *K.A. Pieroni*

Date: 6-21-99

Country of Citizenship: United States of America

Residence: 12895 Treeview Place
Fullerton, California 92835

Full name of first or sole inventor: Jim Eli Saffie

Inventor's signature: *Jim Saffie*

Date: 6/21/99

Country of Citizenship: Chile

Residence: 860 Pico Blvd.
Santa Monica, California 90405